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An Overview of Ottoman Scientific Activities

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AN OVERVIEW OF OTTOMAN SCIENTIFIC ACTIVITIES*

Prof. Ekmeleddin Ihsanoglu**

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"Ottoman Science" is a term encompassing the scientific activities that occurred throughout the Ottoman epoch in the lands where the empire extended. The Ottoman Empire, which was established as a small principality at the turn of the fourteenth century, gradually expanded into the lands of the Byzantine Empire both in Anatolia and the Balkans. Its sovereignty reached the Arab world after 1517. It became the most powerful state of the Islamic world in a vast area extending from Central Europe to the Indian Ocean and persisted by keeping the balances of power with Europe. Following its defeat in World War I, the Ottoman Empire disintegrated in 1923.

Ottoman science emerged and developed on the basis of the scientific legacy and institutions of the pre-Ottoman Seljukid period in Anatolian cities, and benefited from the activities of scholars who came from Egypt, Syria, Iran, and Turkestan, which were the most important scientific and cultural centers of the time. The Ottomans brought a new dynamism to cultural and scientific life in the Islamic world and enriched it. Thus, the Islamic scientific tradition reached its climax in the sixteenth century. Besides the old centers of the Islamic civilization, new centers flourished, such as Bursa, Edirne, Istanbul, Skopje, and Sarajevo. The heritage, which developed in this period, constitutes the cultural identity and scientific legacy of present-day Turkey as well as several Middle Eastern, North African, and Balkan countries. This article aims to give an overview of the formation and development of Ottoman science in Anatolia and the scientific activities, which expanded later from Istanbul, the capital of the empire, to Ottoman lands.

The Ottomans always sought solutions to the intellectual and practical problems they encountered in Islamic culture and science. But when the scientific and industrial revolutions occurred in Europe, a gap emerged between them and the Western world. Thus, Ottomans began to make some selective transfers from Western science, and gradually the scientific tradition began to change from "Islamic" to "Western". Ottoman science should therefore be studied under two headings; the classical Islamic tradition and the modern Western one. Although it is difficult to demarcate the two traditions in a clear-cut way in the transition period, as the contacts became more frequent, the two periods were separated more clearly.

In the classical period, the *madrasa* (in Arabic; college) was the source of science and education and the most important institution of learning in the Ottoman Empire. The Ottoman *madrasas* continued their activities from the establishment of the state until approximately the turn of the twentieth century. The basic structure of the *madrasas* remained the same within the framework of the Islamic tradition, but in terms of organization they underwent several changes in the Ottoman period. Starting with the first *madrasa* established in 1331 in Iznik (Nicaea) by Orhan Bey, the second Ottoman sultan (1326–1362), all

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madrasas had *waqfs* (public foundations) supporting their activities. The *waqfiyes* (the deed of endowment of a *waqf*) of important *madrasas* stipulated that both the religious *(ulūm al-sharia)* and rational sciences (*ulūm al-awāil*) such as mathematics, astronomy, medicine, and physics be taught in these institutions. Besides the *ulema* who provided religious, scientific, and educational services, the *madrasas* also trained the administrative and judicial personnel for bureaucratic posts. The *ulema*, members of the Muslim learned, cultural, and religious institution (*Ilmiye*) who played an important role in every aspect of social and official life, were recruited from the *madrasas*. They had a twofold duty of interpreting and implementing Islamic law; the *mūftīs* fulfilled the first of these duties and the *qādīs* (judges) the second. The *ulema* were responsible for applying the *sharīa* (the sacred law of Islam) and *Qānūn* (Sultanic law) in the affairs of state. Starting from the reign of Mehmed II (Fātih, known as the Conqueror, 1451–1481), the number of *madrasas* increased considerably; to facilitate differentiation among them, they were given ranks. (For the Fatih Kulliye picture see Figure 1).

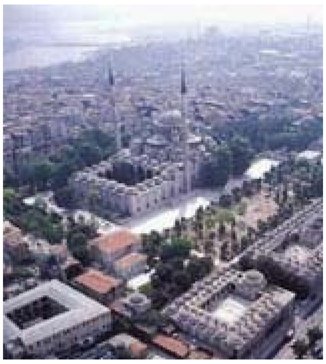


Figure 1. *An overwiev of the Fatih Kulliye (From http://www.jellesen.dk/webcrea/places/istanbul/istanbul.html).*

Shortly after Mehmed II conquered Istanbul, he built the Fātih *Külliye* (complex) which comprised a mosque located at the center, as well as colleges, a hospital, a *mektep* (elementary mosque school), a public kitchen, and other components located around the mosque. It set an example for similar edifices built by the sultans' successors and high-ranking members of the ruling class. The *Sahn-i Samān Madrasas* (Eight Court Colleges) of the Fātih Complex, comprising sixteen adjacent *madrasas*, represented the first Ottoman *madrasas* that had the structure of a university campus.. Owing to the political stability and economic prosperity of the period of the Conqueror, distinguished scholars and artists of the Islamic world assembled in the capital of the empire. The Ottomans particularly protected the Muslim and Jewish scientists fleeing from the persecution that took place after the fall of Granada in 1492, providing them shelter in Ottoman lands. Moreover, as the *waqfs*, which were the financial sources of madrasas, grew rich, scientific and educational life developed further.

The scholars who graduated from the *madrasas* served as teachers, *qādīs*, kazaskers (military judges) and chief *müftīs*. Several physicians were trained and many patients were treated in the *darüssifa* (hospital) of Fātih Complex, which was active until the mid-nineteenth century. The Fātih Complex provided services for the society in various areas such as religion, education and science, health, and nourishment. From the second half of the nineteenth century, as the activities of the Fātih Complex became gradually ineffective, its various units, namely its hospital, its *tābhāne* (hospice), its *muvakkithāne* (timekeeper's office), caravanserai, and school fell out of service. Finally, when all *madrasas* were closed in the Republican

Period, its colleges, too, became inactive in 1924. The mosque of the Complex, however, has preserved its principal function to a considerable extent from its establishment until the present day.

The establishment of the Süleymāniye *Külliye* by Süleyman the Magnificent (1520–1566) in the sixteenth century marked the final stage in the development of the *madrasa* system where, besides the conventional *madrasas*, a specialized one named *Dārüttib* (Medical College) was founded. Thus, for the first time in Ottoman history, in addition to the *sifahanes* (hospitals), an independent institution was established to provide medical education. The other specialized *madrasas* established by the Ottomans were the *Dārülhadīs* and the *Dārülkurrā*. The *Dārülhadīs* had the highest rank in the *madrasa* hierarchy.

In addition to the *madrasas*, which gave basic education, there were the institutions where medical sciences and astronomy were practiced and taught by the master-apprentice method. These were the *sifahanes*, the office of *müneccimbasi* and the *muvakkithānes*.

The institutions, which provided health services and medical education, were called *darüssifa, sifahane* or *bīmāristan*. The Seljukids had built *darüssifas* in the cities of Konya, Sivas, and Kayseri. Similarly, the Ottomans built several *darüssifas* in cities such as Bursa, Edirne, and Istanbul. Some Western sources mention that there were a great number in Istanbul in the sixteenth and seventeenth centuries. This indicates the importance that Ottomans attributed to *darüssifas*. The Ottoman *darüssifas* were not constructed as independent buildings, but as part of a *külliye*.

In the Ottoman palace administration, the person in charge of directing the astronomers was called *müneccimbasi*, i.e. chief astronomer. The position of chief astronomer was established sometime between the late fifteenth and early sixteenth centuries. The chief astronomers were selected from among the *ulema* who were graduates of *madrasas*. From the sixteenth century, they started to prepare calendars, fasting timetables, and horoscopes for the palace and prominent statesmen. Until 1800 the calendars were made according to the *Zīj* (astronomical handbook) of Ulugh Beg; after that the *Zīj* of Jacques Cassini was used. The chief astronomer and sometimes a senior astronomer fixed the most propitious hour for important or trivial events such as imperial accessions, wars, imperial births, wedding ceremonies, the launching of ships, etc. Moreover, the chief astronomers followed extraordinary events related to astronomy such as the passage of comets, earthquakes, and fires as well as solar and lunar eclipses, and passed this information on to the palace with related interpretations. The administration of the *muvakkithānes* was also a duty of the chief astronomer. Besides these, the observatory founded in Istanbul was administered by the chief astronomer Taqī al-Dīn (d. 1585). (For the Istanbul Observatory and Taqi al-Din's miniature see Figure 2). Thirty-seven held the post of chief astronomer until the end of the empire in 1923. The office of *basmuvakkitlik* (chief of timekeepers) was established in 1927.

The timekeeper's offices (*muvakkithānes*) were public buildings located in the courtyards of mosques or *masjids* in almost every town. They were widely built by the Ottomans especially after the conquest of Istanbul. They were administered by the foundation (*waqf*) of the complex (*külliye*) and the persons who worked in the *muvakkithānes* were named *muvakkit*, meaning the person who kept the time, especially for the prayer hours. The major instruments used in the *muvakkithānes* were the following: quadrant, astrolabe, sextant, octant, hourglass, sundial, mechanical clock, and chronometer. Depending on the level of knowledge of the timekeepers, the *muvakkithānes* functioned as locations where astronomy was taught and also as simple observatories. Thus, some of the *muvakkithānes* were important for the education of

chief astronomers. Indeed, quite a number of successful timekeepers rose to that rank. The chief astronomer appointed the timekeepers. The son of the deceased had priority, and if there were no son, a candidate would be selected by examination.



Figure 2. *Istanbul Observatory and Taqi al-Din's miniature. Shahinshahnameh, Istanbul University Merkez Library, No. F. 1404.*

The Ottoman scientific literature in the classical period was produced mainly within the milieu of the *madrasa*. Scholars compiled several original works and translations in the fields of religious sciences as well as mathematics, astronomy, and medicine, besides a great number of textbooks. These works were written in Arabic, Turkish, and Persian, the three languages called *elsine-i selâse*, which Ottoman scholars knew. In the beginning, the literature was mostly written in Arabic, but from the fifteenth century onwards, Turkish was used more and more. From the eighteenth century, the majority of the scientific works were written in Turkish and upon the establishment of the first printing house in Istanbul in 1727, Ottoman Turkish became the most frequently used language in the transfer of modern sciences.

Bursali Kadizāde-i Rūmī (d. AD 1440, known also as Qādī Zādeh al-Rūmī) made the first important contribution to the development of the Ottoman scientific tradition and literature. He flourished in Anatolia and settled in Samarkand after he compiled his first work. Qādī Zādeh wrote *Sharh Mulakhkhas fī'l-Hay'a* (Commentary on the 'Compendium on Astronomy') and *Sharh Ashkāl al-Ta'sīs* (Commentary on 'The Fundamental Theorems') in Arabic in the fields of astronomy and mathematics and became the chief instructor at the Samarkand *madrasa* and the director of the observatory founded by Ulugh Beg (d. 1449) in Samarkand. (For the Samarkand Observatory Sextant Picture see Figure 3). He was also the co-author of *Zīj-i Jurjānī* (The Astronomical Tables of Ulugh Beg) written in Persian. He simplified the calculation of the sine of a one degree arc in his work *Risāla fī Istikhrāj Jaybi Daraja Wāhida* (Treatise on the Calculation of the Sine of a One Degree Arc). Qādī Zādeh's two students from Turkestan, Ali Kuscu (d. 1474) and Fathullah al-Shirwānī (d. 1486), influenced Ottoman science by disseminating mathematics and astronomy in the Ottoman Empire. In the preface of his work *Sharh Ashkāl al-Ta'sīs*, Qādī Zādeh indicated that the philosophers who ponder about the creation and the secrets of the universe, the jurists (*faqihs*) who give *fetvās* in religious matters, the officials who run the affairs of state, and the *qādīs* who deal with judicial matters should know geometry. Thus, he emphasized the necessity of science in philosophical, religious,

and worldly matters. This understanding reflects a general characteristic of Ottoman science in the classical period. In the period of modernization, however, the Western concept of man's domination of nature through science and technology was foreign to Ottoman scholars.



Figure 3. *The miniature of Mawlanâ Hocazâde Muslihiddin Mustafa. Tarjama-i Shakaik al-Nûmaniya, Topkapi Palace Museum Library, H 1263.*

Other astronomy books of this period included *Urjūza fī Manāzil al-Qamar wa Tulūihā* (Poem on the Mansions of the Moon and their Rising) and *Manzūma fī Silk al-Nujūm* (Poem on the Orbits of the Stars) written by Abd al-Wahhāb ibn Jamāl al-Dīn ibn Yūsuf al-Maridānī in Arabic. The founder of the Marāgha school Nasīr al-Dīn al-Tūsī's two books entitled *Risāla fi'l-Taqwīm* (Treatise on the Calendar) and *Sī Fasl fi'l-Taqwīm* (Thirty Sections on the Calendar) were translated from Persian into Turkish. Ahmed-i Dâ'î (d. ca. 1421) is the translator of the second work.

During this period, Egypt was another source for Ottoman science. Haci Pasa (Celaleddin Hidir) (d. 1413 or 1417), a well-known physician of the time educated in Egypt, wrote two books in Arabic entitled *Shifā al-Asqām wa Dawā al-Ālām* (Treatment of Illnesses and the Remedy for Pains) and *Kitāb al-Taālīm fi'l-Tibb* (Book on the Teaching of Medicine) which played an important part in the development of Ottoman medicine. He had many other works in Turkish and Arabic.

In medicine, the works of Sabuncuoglu Serefeddin (d. ca. 1468) are particularly important in the development of Ottoman medical literature and their influence on Safavid medicine. The first book on surgery that he wrote in Turkish entitled *Jarrāhiyāt al-Khāniyya* (Treatise on Surgery of the Sultans) comprises the translation of Abu'l-Qāsim Zahrāwī's *al-Tasrīf*, a self-contained handbook of the medical arts, and the three sections that he himself wrote. This work is much renowned in the history of Islamic medicine in that it illustrates surgical operations with miniatures for the first time. Besides the classical Islamic medical information, this work contains Turco-Mongolian and Far Eastern influences as well as the author's own experiences.

Ottoman science developed further owing to the personal interest of Mehmed II and the educational institutions that he established after the conquest of Istanbul. Consequently, some brilliant scholars emerged in the sixteenth century and made original contributions to science in this period. Mehmed the Conqueror patronized the Islamic scholars and at the same time ordered the Greek scholar from Trabzon, Georgios Amirutzes, and his son to translate Ptolemy's *Geography* into Arabic and to draw a world map. Mehmed II's interest in European culture had started while he was the crown prince settled in the Manisa Palace. In 1445, Italian humanist Ciriaco d'Ancona and other Italians who were in the palace taught him Roman and European history. While Patriarch Gennadious prepared his work on the Christian belief *Itikādnāme* (The Book on Belief) for the sultan, Francesco Berlinghieri and Roberto Valtorio presented their works *Geographia* and *De re Militari*. Mehmed II also encouraged the scholars of his time to produce works in their special fields. For example, for the comparison of al-Ghazālī's criticisms of peripatetic philosophers regarding metaphysical matters, expressed in his work titled *Tahāfut al-Falāsifa* (The Incoherence of the Philosophers), and Ibn Rushd's answers to these criticisms in his work *Tahāfut al-Tahāfut* (The Incoherence of Inchoherence), he ordered two scholars, Hocazāde and Alā al-Dīn al-Tūsī, each to write a work on this subject.

No doubt the most notable scientist of the Conqueror's period is Ali Kuscu, a representative of the Samarkand tradition. He wrote twelve works on mathematics and astronomy. One of them is his commentary on the *Zīj-i Ulug Bey* in Persian. His two works in Persian, namely, *Risāla fi'l-Hay'a* (Treatise on Astronomy) and *Risāla fi'l-Hisāb* (Treatise on Arithmetic) were taught in the Ottoman *madrasas*. He rewrote these two works in Arabic with some additions under new titles, *al-Fathiyya* (Commemoration of Conquest) and *al-Muhammadiyya* (The Book Dedicated to Sultan Muhammed), respectively. Another noteworthy scholar of the Bayezid II period (1481–1512) was Molla Lūtfi. He wrote a treatise about the classification of sciences titled *Mawdūāt al-Ulūm* (Subjects of the Sciences) in Arabic and compiled a book on geometry titled *Tad'īf al-Madhbah* (Duplication of the Cube) which was partly translated from Greek. Mīrīm Celebi (d. 1525) who was a well-known astronomer and mathematician of this period and the grandson of Ali Kussu and Qādī Zādeh, contributed to the establishment of the scientific traditions of mathematics and astronomy and was renowned for the commentary he wrote on the *Zīj* of Ulugh Beg.

Some scholars who came from Andalusia also contributed to the Ottoman scientific literature. The Arabic medical and astronomical works of the Andalusian scholar Abd al-Salām al-Muhtadī al-Muhammadī (sixteenth century), who settled in Istanbul during the reign of Bayezid II and gave up his Jewish name Ilya ibn Abrām al-Yahūdī after embracing Islam, are examples of such contributions. In a treatise that he wrote in Hebrew and then translated into Arabic in 1503, he introduced the instrument called *al-Dābid*, which was his own invention, and stated that it was superior to the *Dhāt al-halaq* (armillary sphere) invented by Ptolemy. This treatise illuminates an aspect of Ottoman scientific literature that is not much known.

Scientific literature developed considerably in the period of Sultan Süleyman the Magnificent. We find two major mathematical books in Turkish entitled *Jamāl al-Kuttāb wa Kamāl al-Hussāb* (Beauty of Scribes and Perfection of Accountants) and *Umdat al-Ḥ isāb* (Treatise on Arithmetic) by Nasūh al-Silāhī al-Matrāqī (d. 971/1564). His book in Turkish entitled *Beyān-i Menāzil-i Sefer-i Irakeyn* (Description of the Stopping Places on the Campaign to the Two Iraqs), related to geography, should also be mentioned. Mūsā ibn Hāmūn (d. 1554), one of the famous Jewish physicians of Andalusian descent, was appointed as Sultan Süleyman's physician and wrote the first Turkish and one of the earliest independent works on dentistry which is based on Greek, Islamic, and Uighur Turkish medical sources and in particular on Sabuncuoglu Serefeddin's

works. In the sixteenth century, the representatives of the Egypt–Damascus tradition of astronomy-mathematics, wrote important works on astronomy. The greatest astronomer of this period was Taqī al-Dīn al-Rāsid (d. 1585) who combined the Egypt–Damascus and Samarkand traditions. He wrote more than thirty books in Arabic on the subjects of mathematics, astronomy, mechanics, and medicine.

Taqī al-Dīn Râsıd came from Egypt to Istanbul in 1570. In 1571, he was appointed *müneccimbasi* (chief astronomer) by Sultan Selīm II (1566–1574). Shortly after Sultan Murād III's (1574–1595) accession to the throne, he started the construction of the observatory of Istanbul. It is understood from his *Zīj* titled *Sidrat Muntahā'l-Afkār* (The Nabk Tree of the Extremity of Thoughts) that he made observations in the year 1573. It is generally agreed that the observatory was demolished on 4 Dhū'l-Hijja 987 corresponding to 22 January 1580. Therefore, it can be estimated that he carried out observations from 1573 until 1580.

In addition to the instruments of observation which were used until his time, Taqī al-Dīn invented new ones such as the *Mushabbaha bi'l-manātiq* (sextant) and *Dhāt al-awtār* in order to determine the equinoxes. Moreover, he also used mechanical clocks in his observations. When one compares the instruments of observation used by Tycho Brahe (1546–1601), a famous astronomer of this period, and those used by Taqī al-Dīn, one sees that they are very similar.

Taqī al-Dīn developed a different method of calculation to determine the latitudes and longitudes of stars by using Venus and the two stars near the ecliptic, i.e. Aldebaran (Taurus) and Spica Virginis. () He determined that the magnitude of the annual movement of the Sun's apogee was 63". Considering that the value known today is 61", the method he used appears to be more precise than the methods of Copernicus (24") and Tycho Brahe (45").

Starting with Ptolemy in the second century AD and continuing until Copernicus in the sixteenth century, the Western world used chords for measuring angles. For this reason, the calculation of the value of the chord of 1º has been an important matter for astronomers. Thus, while Copernicus used the method based on the calculation of the chord of 2º that yielded an approximate value, Taqī al-Dīn used trigonometric functions such as the sine, cosine, tangent, and cotangent to measure the values of angles, in line with the tradition of Islamic astronomy. Inspired by Ulugh Beg, Taqī al-Dīn developed a different method to calculate the sine of 1º. Furthermore, he applied decimal fractions, which had been previously developed by Islamic mathematicians such as al-Uqlidīsī and al-Kashī, to astronomy and trigonometry prepared sinus and tangent tables accordingly, and used them in his work titled *Jarīdat al-Durar wa Kharīdat al-Fikār*.

The first contact with Copernican astronomy in the Islamic world occurred around mid-seventeenth century when the Ottoman astronomer Tezkereci Köse Ibrāhim Efendi of Szigetvar translated a work by the French astronomer Noel Durret (d. ca. 1650). The introduction and spread of Copernicus' new heliocentric concept into the Ottoman world did not cause a conflict between religion and science, contrary to the case in Europe. This concept, which was first seen as a technical detail, was later preferred to Ptolemy's geocentric system and considered more suitable with respect to religion. However, the conflict between religion and science entered into Ottoman Turkish intellectual life around the end of the nineteenth century together with Western trends of thought such as positivism and biological materialism.

The Ottomans needed knowledge of geography in order to determine the borders of their continuously expanding territory and to establish control over the military and commercial activities in the

Mediterranean, the Black Sea, the Red Sea, and the Indian Ocean. They made use both of the geographical works of classical Islam and of works of European origin. By adding their own observations, Ottoman geographers produced original works as well. The first source of the Ottoman knowledge about geography is the Samarkand tradition of astronomy and geography.

From the sixteenth century onwards, Pirī Reis produced noteworthy geographical works. In 1511, Pirī Reis drew his first map. This map is part of the world map prepared on a large scale. It was drawn on the basis of his rich and detailed drafts and European maps including Columbus' map of America. This first Ottoman map which included preliminary information about the New World represents southwestern Europe, northwestern Africa, southeastern and Central America. It is a portolano, without latitude and longitude lines but with lines delineating coasts and islands. Pirī Reis drew his second map and presented it to Süleyman the Magnificent in 1528. Only the part, which contains the North Atlantic Ocean and the then newly, discovered areas of Northern and Central America is extant. Pirī Reis also wrote a book entitled *Kitāb-i Bahriye* (Book of the Sea, 1521). In this work, Pirī Reis presents drawings and maps of the cities on the Mediterranean and Aegean coasts, and gives extensive information about navigation and nautical astronomy. Admiral Seydī Ali Reis (d. 1562), who wrote the work in Turkish titled *al-Muhīt* (The Ocean), was a notable figure of the period in maritime geography. This work contains astronomical and geographical information necessary for long sea voyages and his own observations about the Indian Ocean. Another work of the sixteenth century, which contains information about the geographical discoveries and the New World, is the book entitled *Tārih-i Hind-i Garbī* (History of Western India). This work, whose author is unknown, was presented to Sultan Murād III in 1583. It was based on Spanish and Italian geographical sources. It is important in showing that the Ottomans knew the geographical discoveries of the West. The work has three parts; the third part, which is the most important and which comprises two thirds of the whole book, relates the adventures of Columbus, Balboa, Magellan, Cretes, and Pizarro during the sixty years from the voyage to America in 1492 until 1552. Apparently, cartography was organized as a profession in the Ottoman Empire; for example, in the seventeenth century, fifteen individuals were occupied with the art of surveying, in eight locations in Istanbul and nearby areas.

From the seventeenth century onwards, the new medical doctrines which were put forward by Paracelsus and his followers in the sixteenth century began to be observed in the Ottoman medical literature under the names of *Tibb-i cedīd* (new medicine) and *Tibb-i kimyāī* (chemical medicine), in the works of Ṣāliḥ ibn Nasrullāh (d. 1669), Omar ibn Sinan al-Izniki (eighteenth century), and Omar Sifāī (d. 1742). Semseddin Itākī's book on anatomy (1632) reflects the first influences of European anatomists. Ottoman medical literature carried both classical Islamic and European medical information side by side until the beginning of the nineteenth century when Sānīzāde Atāullah (d. 1826) wrote his work entitled *Hamse-i Sānīzāde* (Five Works of Sānīzāde) composed of four parts (physiology, pathology, surgery, and pharmacology) based totally on European sources without any reference to traditional medicine.

From the seventeenth century onwards, conditions were no longer conducive to the development of science because of the social and economic disruption resulting from the weakening of the central authority, dissolution of political stability, decreasing conquests, loss of land, influx of abundant American silver into Europe, and the diminishing revenues of the empire. The factors that had encouraged scholars to conduct scientific work disappeared and were replaced by the struggle to make a living. Disputes arose in the seventeenth century between the supporters of *salafī* Islam and mysticism among Ottoman intellectuals.

The upholders of *salafīya*, who started the movement known as the Kadizādeli, had a negative attitude to philosophy and science that led to the regression of Ottoman science.

The famous Ottoman scholar and bibliographer Kâtip Celebi (d. 1658), who is also known under the name of Haci Halife, was one of the first Muslim intellectuals to notice the gap between the levels of scientific development of Europe and the Ottoman world. Kâtip Celebi was able to approach analytically both classical Islamic culture and modern Western culture. He wrote in Arabic and Turkish on a variety of subjects. In history, he translated from Latin the *Chronik* of Johann Carion that he titled *Tārih-i Firengī Tercümesi* (Translation of European History) and compiled his *Ravnak al-Saltana* (Splendor of the Sultanate) on the basis of works by authors such as Johannes Zouaras, Nicestas Acominate, Nicephorus Gregoras, and the Athenian Laonikas Chalcondyle. In the field of geography, he translated the *Atlas Minor* of Mercator and Hondius under the title *Lawami$$ al-Nur fi Zulmat Atlas Minur* (Flashes of Light on the Darkness of Atlas Minor). Furthermore, in his work titled *Mīzān al-Haqq fī Ikhtiyār al-Ahaqq* (The Balance of Truth and the Choice of the Truest), Kâtip Celebi criticized the intellectual life of his period.

The Ottoman world was the first environment with which Western science came into contact outside its own milieu, due to the close interaction and geographical proximity of the Ottomans with European countries. In the early periods when the Ottomans had contact with and transferred some Western techniques (especially firearms, cartography, and mining) they also had some early contacts with Renaissance science (astronomy, medicine) through the emigrant Jewish scholars. Particularly in the early centuries, this interest of the Ottomans developed in a selective manner because of their feeling of superiority and their autarchic system. But functional transfers from European science developed gradually because of increasing needs, as the military, political, and economic balances turned against them. In these periods, the Ottomans required immediate transfers of science and technology to strengthen their military power. Thus, they established the imperial engineering schools at the end of the eighteenth century and the imperial medical school at the beginning of the nineteenth century. Major reforms known as the *Tanzīmāt* (1839) led to a shift in the process of selective transfer to include public ends and civilian objectives. In the second half of the nineteenth century individuals started to establish professional and learned associations similar to those in the West. These new corporate bodies with their legal statute and work procedures, which did not exist in the classical period, added a new dimension to Ottoman cultural and scientific life.

Ishak Efendi (d. 1836), who was chief instructor in the Imperial School of Engineering, had a leading role in the transfer of modern science. Among his thirteen books, which he wrote using Western and particularly French sources, *Mecmūa-i Ulūm-i Riyāziye* (Compendium of Mathematical Sciences, four volumes) is of special importance, since it is the first attempt in any language of the Muslim world to present a comprehensive textbook on different sciences such as mathematics, physics, chemistry, astronomy, biology, botany, and mineralogy in one compendium. Ishak Efendi's efforts to find the equivalents of the new scientific terminology and his influence on the transfer of modern science spread in other Islamic countries beyond Ottoman Turkey.

The Ottomans' interest was oriented towards practical ends and the application of scientific discoveries, while the three main aspects of modern Western science, namely theory, experiment, and research were not taken into consideration. This understanding was reflected in the educational and scientific policy of the Ottoman State before and during the *Tanzīmāt* period. The Ottomans made several attempts to establish an institution for higher education under the name of *Dārülfünūn* (House of sciences), apart from the *madrasa*,

in line with the model of the European university. However, they disregarded the importance of scientific research in the program of this institution and those of the previously established ones. For this reason, they were not as successful as their counterparts in Russia and Japan. The dimension of research was introduced to Ottoman scholarly circles upon the establishment of the Faculty of Sciences (1900), which started to function as a part of Istanbul University.

Ottoman contacts with European science and technology started with the purpose of fulfilling their needs, in a selective way. However, after a long process, they abandoned their own scientific traditions and began to think that development and progress could only be accomplished through Western science and technology.

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